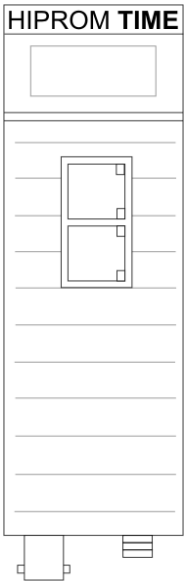
1756HP-TIME

USER MANUAL

V2.03.00



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INTRODUCTION

The 1756HP-TIME module provides accurate time synchronization on a number of interfaces using Global Positioning System (GPS). The module also has the ability to obtain time from various sources and provide time synchronization on other, thus acting as a gateway between different time synchronization methods.

Time synchronization can be done using the Allen-Bradley ControlLogix backplane (CST and UTC conversion), IRIG-B-122 (OUT and IN), Ethernet Precision Time Protocol (PTP) and Ethernet Network Time Protocol (NTP).

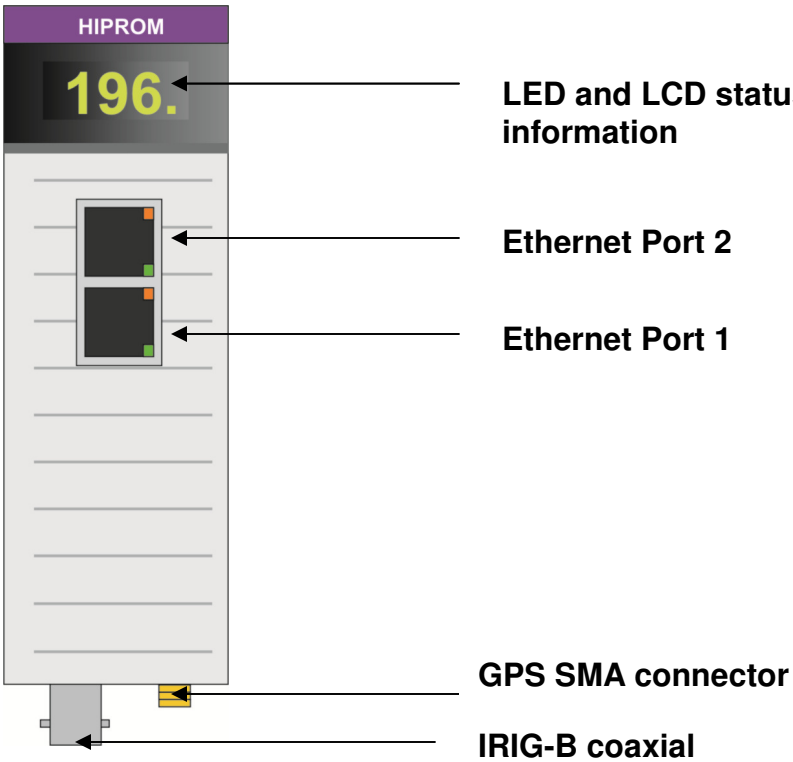
The module also provides GPS position in XYZ Cartesian ECEF (Earth Centered, Earth Fixed) and LLA (latitude, longitude and altitude). Velocity (m/s) is also provided in XYZ Cartesian ECEF and ENU (East-North-UP). When using an external antenna the module can provide has precision position (2.5mm).

This document serves to describe the functionality, installation, configuration and operation of the module.

INSTALLATION

Hardware

The 1756HP-TIME module is designed to operate within the Allen-Bradley ControlLogix platform. All power required for the module's operation is derived from the ControlLogix backplane.



1756HP-TIME Front View

LED and LCD information

All information regarding the module status, pulse per second (PPS), IP address etc. will be given via the LCD and LED indicators. Please view *Module Status* section for more information.

Ethernet Port 1 and Ethernet Port 2

PTP and NTP time synchronization is done via the dual port switch.
The switch supports a Device Level Ring (DLR) which can be used to ensure a failsafe Ethernet Ring.

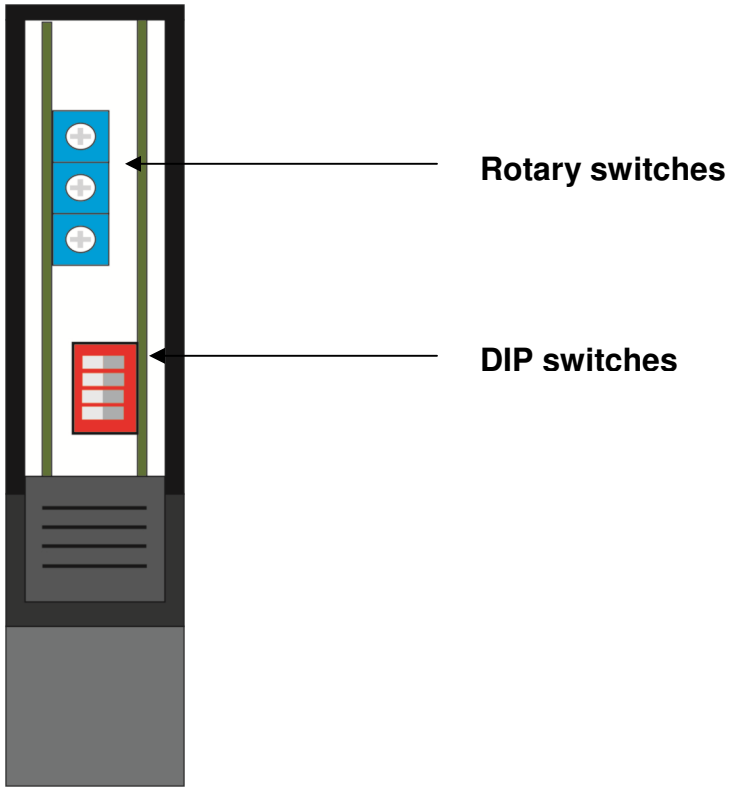
NOTE: **This port is not a bridge to the backplane and cannot be used to view modules on the backplane.**

GPS SMA Connector

This connector is used to connect the GPS bullet antenna. The installation of this antenna will be explained later in this section.

IRIG-B coaxial connector

The IRIG-B coaxial connector is used to connect the module to an IRIG-B network. Depending on the module configuration it can be a Master or Slave on the IRIG-B network.



1756HP-TIME Top View

Rotary switches

The rotary switches are used to select certain options on the Ethernet interface of the 1756HP-TIME module. The settings will be explained in the *Module Configuration* section.

DIP switches

These are used to select certain general operation options for the module. The settings will be explained in the *Module Configuration* section.

GPS Antenna installation

The bullet antenna must be installed with a clear view of the sky (nothing obstructing the view of the antenna to the sky). If an antenna is installed with a limited view of the sky the GPS receiver will either have a low satellite lock count or will not be able to obtain lock. This will result in low accuracy time synchronization.

Software

The user will need the following software to configure and use the 1756HP-TIME:

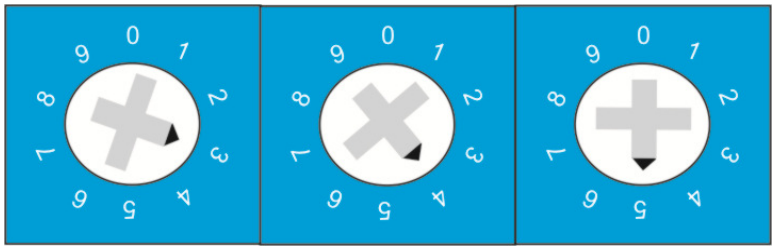
- RSLogix 5k ladder example code
- Add-on Profile (AOP)

Both the applications can be found on the product CD or the Hiprom Technologies website: www.hiprom.com

SETUP

Hardware

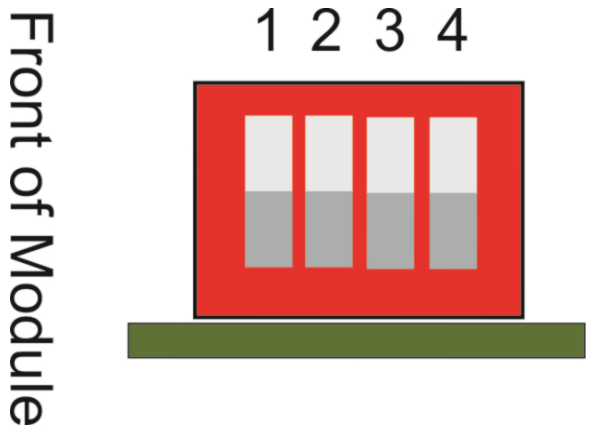
Rotary switches
With zero at the top of the rotary switches the digits will be entered from left to right. For example if you were to select 345 on the switches it would be done as shown below:



Below are the options that can be selected:

Switch	Description
1 – 254	When values between 1 and 254 are selected the module will default to an IP address 192.168.1.X, where X will be the value of the rotary switches selected.
888	This will set the module to reset all settings to Out-of-the-box.
900	BOOTP will be selected which removes the current IP address. The new IP address must be set with a BOOTP server.

DIP switches
The switches are numbered as shown below:



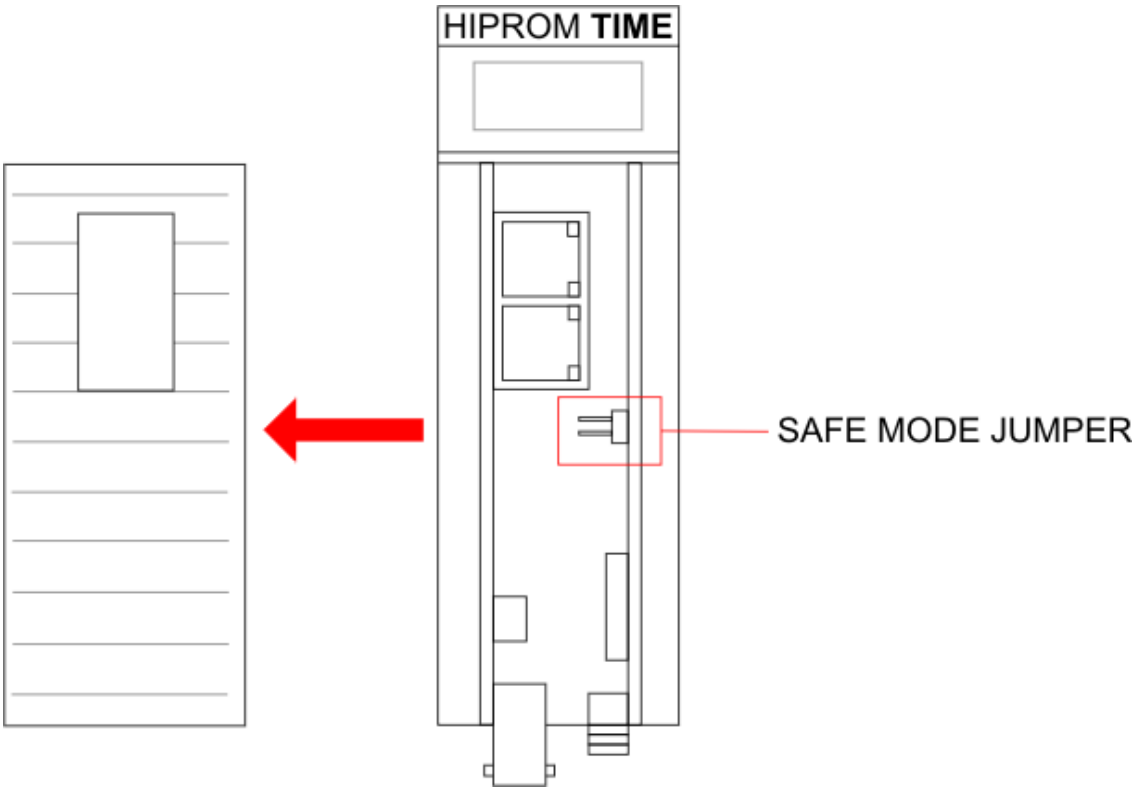
Switch	Description
1	This is used for debugging the module. The user must never set this.
2	This is reserved for future use.
3	This is reserved for future use.
4	The user can select if the battery must be connected to the GPS receiver

	and keep the last satellite data. This will help to speed up the process of getting GPS Lock when the module is rebooted if power was lost.

SAFE MODE

The module has the option to run the firmware that it was originally shipped with. This can be used in the case where the power was cycled whilst flashing the firmware. Thus if the module does not boot because of the corrupted firmware the user can set the module into safe mode and re-flash the module. The Safe Mode jumper is located under the front cover as shown below:

NOTE: **The module must be placed back into non-SAFE MODE to avoid running old firmware even if the module has been flashed with new firmware.**



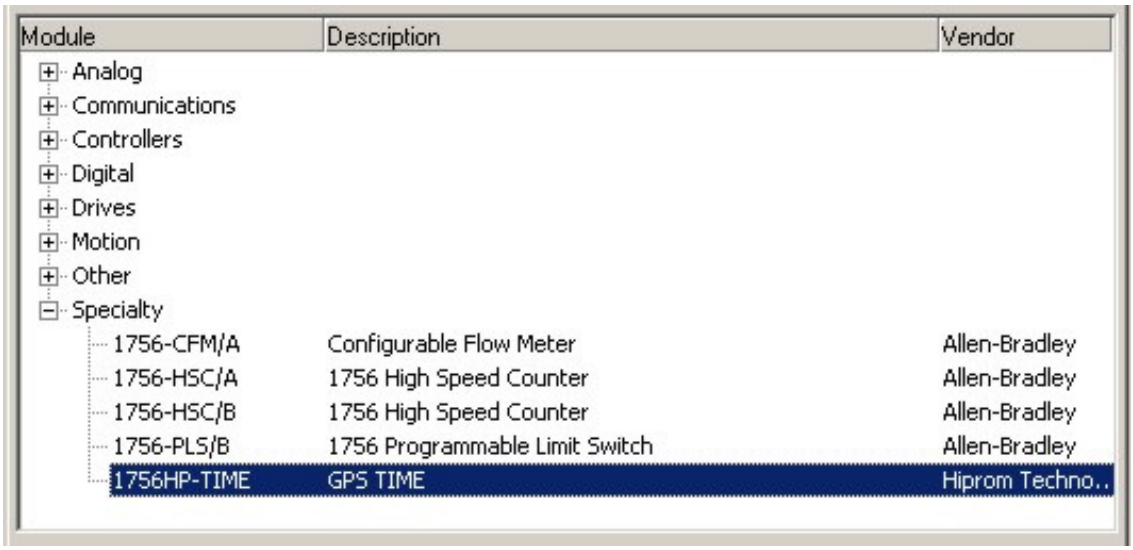
RSLogix

This section describes the procedures required to configure the 1756HP-TIME module within the Logix platform.

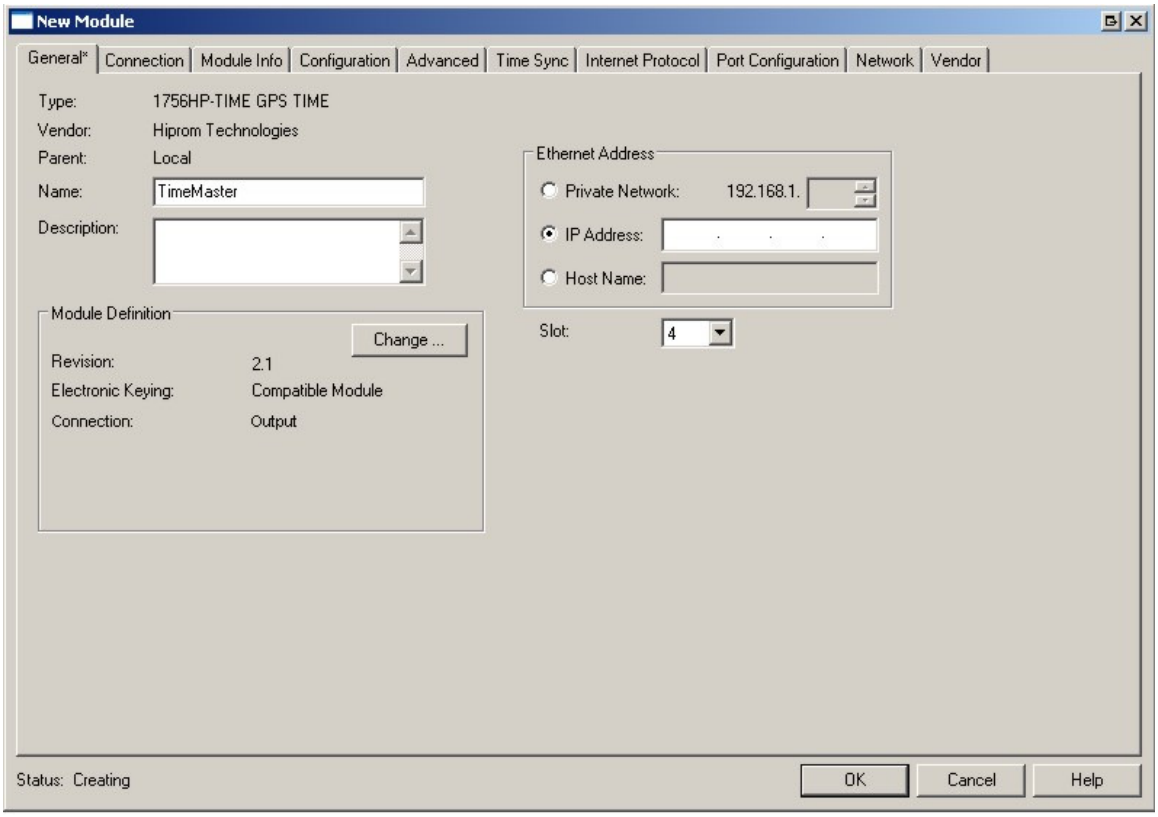
NOTE: **Each 1756HP-TIME module must be owned by a single Logix Controller.**

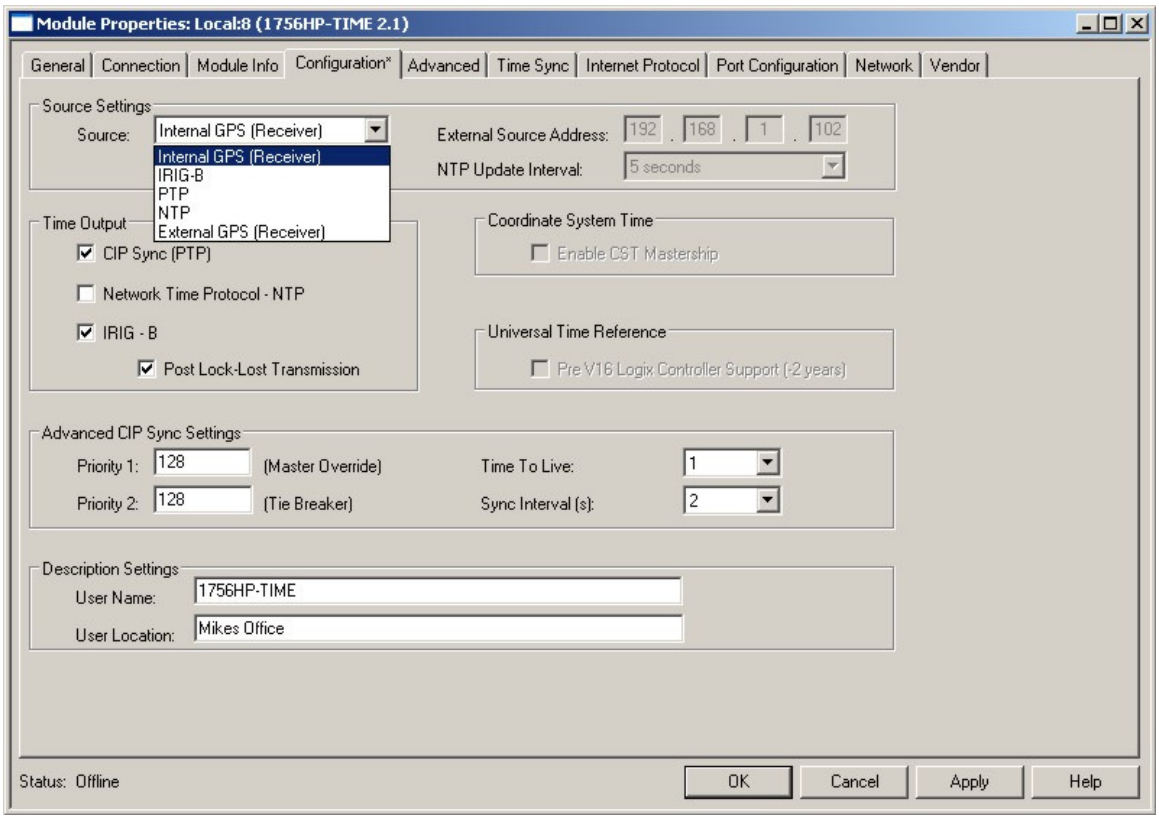
The user must select the GPS TIME Module in RSLogix when adding the module to the IO tree in RSLogix 5k.

In order for this option to be available the Module AOP must be installed. The installer can be found on the accompanying CD or alternatively can be downloaded from the Hiprom technologies website: www.hiprom.com

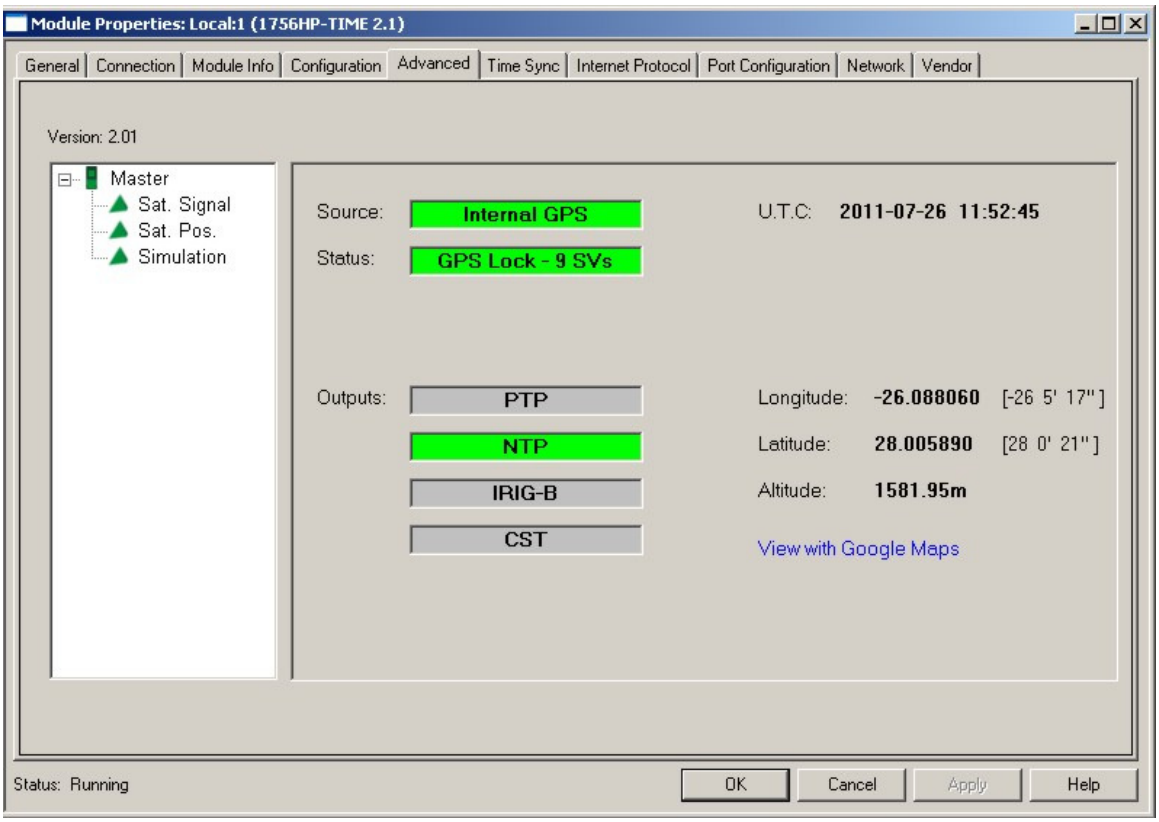


The following window will appear allowing the set up of the time module.

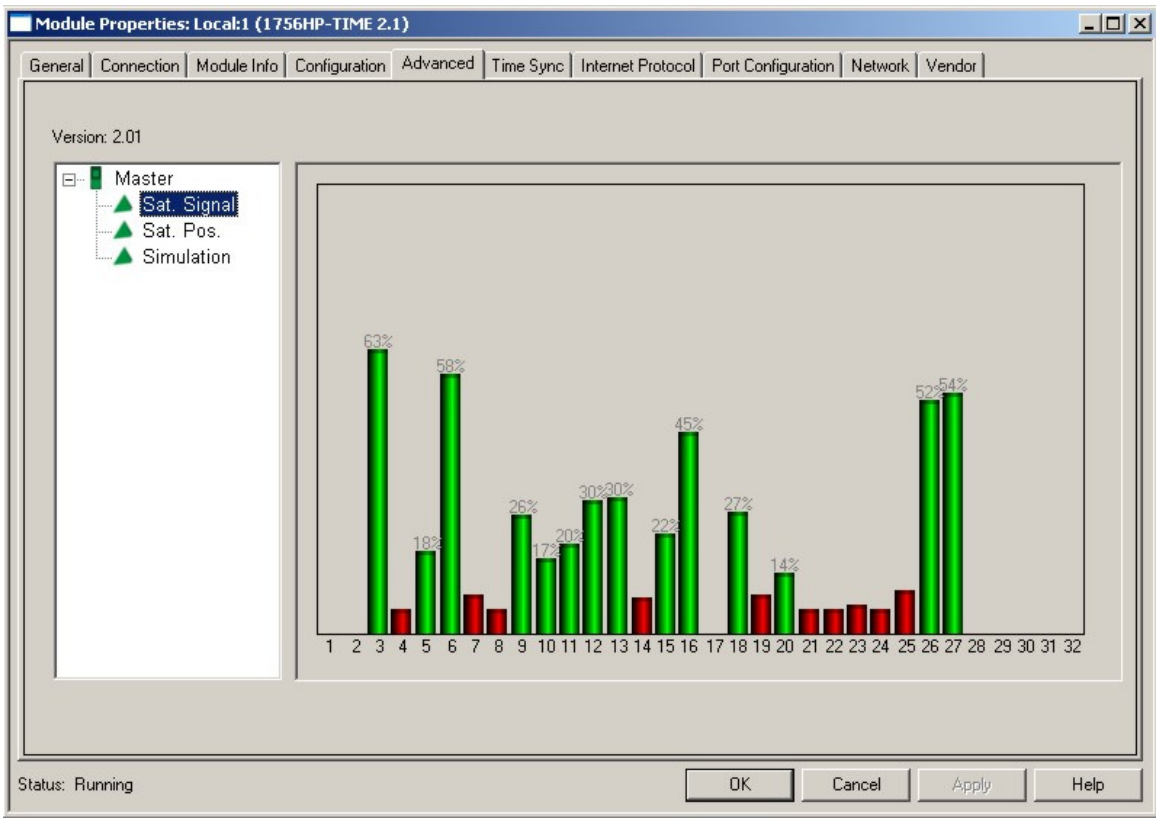


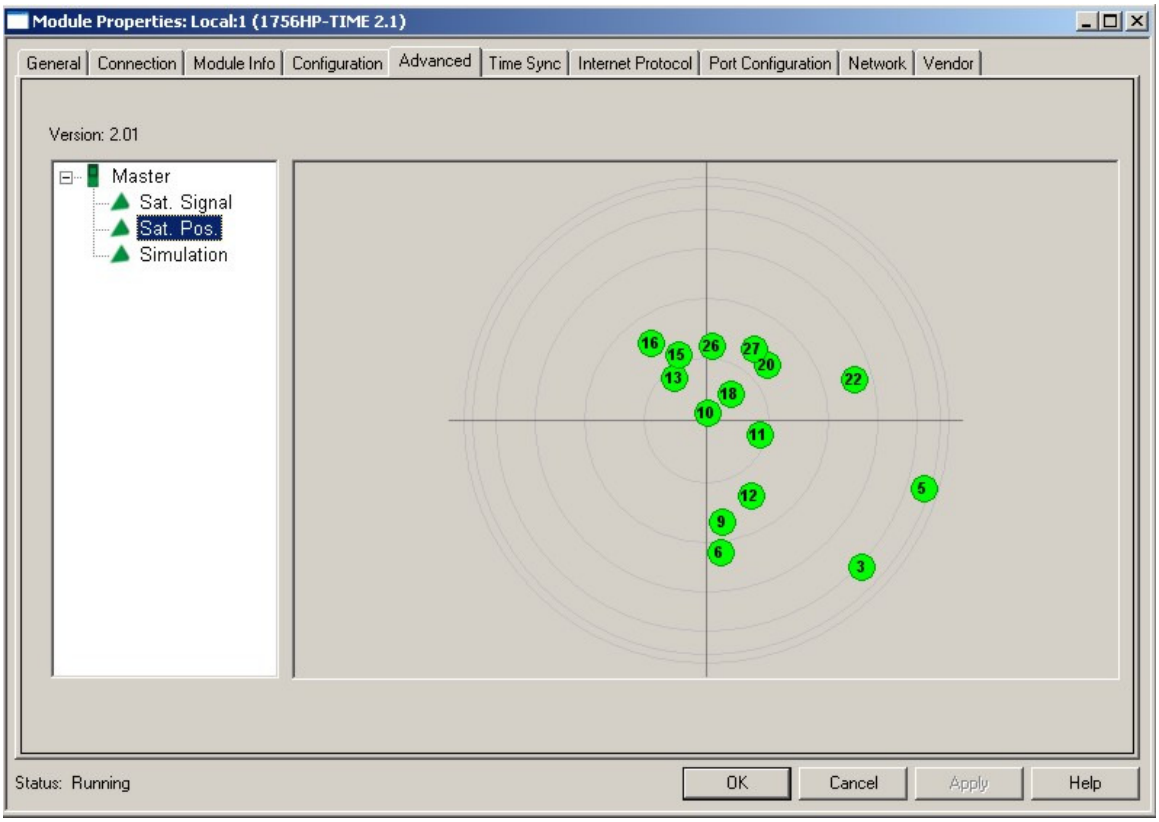


Clicking on the configuration tab allows one to set the time source, the output time format as well as other CIP sync settings and descriptions.



The advanced tab allows one to see the status of the Time Module. It shows the source of the time, as well as whether it is a valid time (green – valid, red – not valid) along with the time outputs. It also gives the UTC time of the module, and if the GPS antenna is connected and has clear sky view it will give the co-ordinates.
The navigation tree to the left of the tab also lets one see the signal strength of the satellites as well as the position in the sky, and allows one to set the module in simulation mode.


Module Properties: Local:1 (1756HP-TIME 2.1)
General
Connection
Module Info
Configuration
Advanced
Time Sync
Internet Protocol
Port Configuration
Network
Vendor
Version: 2.01
Master
Sat. Signal
Sat. Pos.
Simulation
63%
58%
18%
26%
17%
20%
30%
30%
22%
45%
27%
14%
52%
54%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Status: Running
OK
Cancel
Apply
Help


Module Properties: Local:1 (1756HP-TIME 2.1)
General
Connection
Module Info
Configuration
Advanced
Time Sync
Internet Protocol
Port Configuration
Network
Vendor
Version: 2.01
Master
Sat. Signal
Sat. Pos.
Simulation
16
15
26
27
20
13
22
18
10
11
12
5
9
6
3
Status: Running
OK
Cancel
Apply
Help

The following configuration tags can all be set from within the AOP, descriptions of each of the configuration parameters follow.

Local:8:C	{...}	{...		HT:1756HP_TIME:C:0
Local:8:C.Source	4		Decimal	INT
Local:8:C.Control	2#0000_0000_0000_1101		Binary	INT
Local:8:C.CIPSyncOutputEnable	1		Decimal	BOOL
Local:8:C.NTPOutputEnable	0		Decimal	BOOL
Local:8:C.IRIGBOutputEnable	1		Decimal	BOOL
Local:8:C.IRIGBLockLostTx	1		Decimal	BOOL
Local:8:C.PreV16Support	0		Decimal	BOOL
Local:8:C.CSTMastershipEnable	0		Decimal	BOOL
Local:8:C.NTPUpdateInterval	5		Decimal	DINT
Local:8:C.ExternalSourceAddress1	192		Decimal	INT
Local:8:C.ExternalSourceAddress2	168		Decimal	INT
Local:8:C.ExternalSourceAddress3	1		Decimal	INT
Local:8:C.ExternalSourceAddress4	102		Decimal	INT
Local:8:C.Priority1	127		Decimal	INT
Local:8:C.Priority2	127		Decimal	INT
Local:8:C.CIPSyncTimeToLive	1		Decimal	INT
Local:8:C.CIPSyncInterval	4		Decimal	SINT
Local:8:C.AdvancedConfig	0		Decimal	DINT
Local:8:C.DemoWeekNumber	0		Decimal	DINT
Local:8:C.DemoWeekSeconds	0		Decimal	DINT
Local:8:C.SpareDINT	0		Decimal	DINT
Local:8:C.UserName	{...}	{...	ASCII	SINT[64]
Local:8:C.UserLocation	{...}	{...	ASCII	SINT[64]

Source
This indicates to the module what will be used as the time source. The values to the right are for each time source provided.

1	GPS
2	IRIG-B
3	PTP
4	NTP
5	External

CIPSyncOutputEnable
When this bit is set the module will enable PTP synchronization on Ethernet. Thus the module will be a master or source.

0	1588 PTP output is disabled
1	1588 PTP output is enabled

NTPOutputEnable
When this bit is set the module will enable NTP on Ethernet. Thus the module will be a master or source.

0	NTP v3 RF(1305) output is disabled
1	NTP v3 RF(1305) output is enabled

IRIGBOutputEnable
When this bit is set the module will enable IRIG-B on the coaxial interface. Thus the module will be a master or source.

0	IRIG-B-122 output is disabled
1	IRIG-B-122 output is enabled

IRIGBLockLostTX
When this bit is set the module will keep sending an IRIG-B signal even when it has lost lock to the time source. If this bit is clear the module will stop sending a valid IRIG-B signal when it has lost lock with the time source.

0	Module will stop sending IRIG-B when lock is lost
1	Module will continue sending IRIG-B even when lock is lost

PreV16Support
If the user is using RSLogix 5000 v16 and newer the UTC time base is different from previous versions of RSLogix. To ensure that ControlLogix PLC's running different versions can be time synced using the 1756HP-GPS module the user must select if v16 and newer is used or not.

0	UTC time base used is for V16 and newer
1	UTC time base used is for V15 and older

CSTMastershipEnable
The bit indicates if the module will be the CST Master on the local rack (if no other CST Masters are currently active). Thus when set the module will attempt to be the CST Master.

0	Module will not attempt to be the CST Master
1	Module will attempt to be the CST Master

NTPUpdateInterval

The time (in seconds) at which the module will request an update of the time from the NTP server.

Allowed values:	
5	5 seconds
30	30 seconds
300	5 minutes
3600	1 hour
86400	1 day
604800	1 week

ExternalSourceAddress
The external source address is used for one of two sources depending on how the configuration is set. If the time source is set to NTP then this will be the IP address of the source that must be used. If the source is set to External GPS then this will be the IP address of the GPS receiver.

Example:	
Byte 0 = 192 Byte 1 = 168 Byte 2 = 1 Byte 3 = 100	The module will used external IP address: 192.168.1.100

Priority1
The priority is used to force a module to become the time master on a network where it is not necessarily the best source of time. Default is 128, any lower values indicate preference.

Default:	
128	Values lower than 128 indicate preference on the network

Priority2
This is used to break a tie between two modules with the same priority 1 value.

Default:	
128	Values lower than 128 indicate preference on the network

CIPSyncTimeToLive
A mechanism that limits the lifespan of data in a network. It prevents the TCP packet from circulating indefinitely.

Example:	
1	The packet will circulate once

CIPSyncInterval
The time interval that the module will send out a PTP sync packet.

Allowed Values:	
1/8	125 milliseconds
1/4	250 milliseconds
1/2	500 milliseconds
1	1 second
2	2 seconds

AdvancedConfig
These are various bits used to set certain options in the module.

Bit:	
0	Demo Mode
1 - 31	Reserved

DemoWeekNumber

Example:	
29 April 2010	Week number = 1581

When the module is in demo mode this can be used to set the initial date to be used by the module. The week number is the week count since 6 Jan 1980.	
DemoWeekSeconds This is the amount of seconds that have passed since the beginning of the week. The seconds count begins with 0 each Sunday morning at midnight GPS time.	**Example:** | Sunday 1am | Week Seconds = 3600
UserName Helps to identify the time module, visible in CIPSync syncronisation.	**Example:** | 1756HP-TIME
UserLocation Can be used to provide extra information helping to identify the location of the module	**Example:** | RemoteRack_Slot4

OPERATION

RSLogix

Each 1756HP-TIME consumes 1 connection from the Logix Controller.

Local:8:I	{...}	{...		HT:1756HP_TIME:I:0
Local:8:I.CommStatus	0		Decimal	DINT
Local:8:I.Source	4		Decimal	INT
Local:8:I.ModuleStatus	135004160		Decimal	DINT
Local:8:I.Time	{...}	{...		HT:1756HP_CLOCK:I:0
Local:8:I.Time.Status	2#0000_0000_0000_0...		Binary	DINT
Local:8:I.Time.TimeValid	0		Decimal	BOOL
Local:8:I.Time.CIPSyncOutputEnabl...	0		Decimal	BOOL
Local:8:I.Time.NTPOutputEnabled	0		Decimal	BOOL
Local:8:I.Time.IRIGBOutputEnabled	0		Decimal	BOOL
Local:8:I.Time.CSTMasterEnabled	0		Decimal	BOOL
Local:8:I.Time.CSTMastership	0		Decimal	BOOL
Local:8:I.Time.CSTDuplicateDetect	0		Decimal	BOOL
Local:8:I.Time.DemoModeActive	0		Decimal	BOOL
Local:8:I.Time.Year	0		Decimal	DINT
Local:8:I.Time.Month	0		Decimal	DINT
Local:8:I.Time.Day	0		Decimal	DINT
Local:8:I.Time.Hour	0		Decimal	DINT
Local:8:I.Time.Minute	0		Decimal	DINT
Local:8:I.Time.Second	0		Decimal	DINT
Local:8:I.Time.MicroSecond	0		Decimal	DINT
Local:8:I.UTC	{...}	{...	Decimal	DINT[2]
Local:8:I.CST	{...}	{...	Decimal	DINT[2]
Local:8:I.CSTOffset	{...}	{...	Decimal	DINT[2]
Local:8:I.GPS	{...}	{...		HT:1756HP_GPS:I:0
Local:8:I.GPS.GPSStatus	2#0000_0000_0000_0000		Binary	INT
Local:8:I.GPS.GPSLock	0		Decimal	BOOL
Local:8:I.GPS.AntennaOK	0		Decimal	BOOL
Local:8:I.GPS.PDOPOk	0		Decimal	BOOL
Local:8:I.GPS.WarmStart	0		Decimal	BOOL
Local:8:I.GPS.DGPS	0		Decimal	BOOL
Local:8:I.GPS.PPS	0		Decimal	BOOL
Local:8:I.GPS.FaultCode	0		Decimal	INT
Local:8:I.GPS.Mode	0		Decimal	INT
Local:8:I.GPS.SVCount	0		Decimal	INT
Local:8:I.GPS.Latitude	0.0		Float	REAL
Local:8:I.GPS.Longitude	0.0		Float	REAL
Local:8:I.GPS.Altitude	0.0		Float	REAL
Local:8:I.GPS.PositionX	0.0		Float	REAL
Local:8:I.GPS.PositionY	0.0		Float	REAL
Local:8:I.GPS.PositionZ	0.0		Float	REAL
Local:8:I.GPS.RelativePositionX	0.0		Float	REAL
Local:8:I.GPS.RelativePositionY	0.0		Float	REAL
Local:8:I.GPS.PositionZ	0.0		Float	REAL
Local:8:I.GPS.RelativePositionX	0.0		Float	REAL
Local:8:I.GPS.RelativePositionY	0.0		Float	REAL
Local:8:I.GPS.RelativePositionZ	0.0		Float	REAL
Local:8:I.GPS.VelocityNorth	0.0		Float	REAL
Local:8:I.GPS.VelocityEast	0.0		Float	REAL
Local:8:I.GPS.VelocityUp	0.0		Float	REAL
Local:8:I.GPS.VelocityPostionX	0.0		Float	REAL
Local:8:I.GPS.VelocityPostionY	0.0		Float	REAL
Local:8:I.GPS.VelocityPostionZ	0.0		Float	REAL

INPUT IMAGE

CommStatus This is reserved.	This is reserved
Source This indicates the current time source. The values to the right are for each time source provided.	1 GPS 2 IRIG-B 3 PTP 4 NTP 5 External
ModuleStatus This is reserved.	This is reserved
Time.TimeValid When this bit is set a valid time is being received from the time source.	0 Time being received from source is invalid 1 Time being received from source is valid
Time.CIPSyncOutputEnable When 1588 Output PTP has been enabled in the config this will be set.	0 1588 PTP output is disabled 1 1588 PTP output is enabled
Time.NTPOutputEnable When NTP Output has been enabled in the config this will be set.	0 NTP v3 RF(1305) output is disabled 1 NTP v3 RF(1305) output is enabled
Time.IRIGBOutputEnable When IRIG-B Output has been enabled in the config this will be set.	0 IRIG-B-122 output is disabled 1 IRIG-B-122 output is enabled
Time.CSTMasterEnabled When the module will attempt to be the CST Master this will be set.	0 Module will not attempt to be the CST Master 1 Module will attempt to be the CST Master
Time.CSTMastership If the module is the CST Master on the local rack then this bit will be	0 Module is not the CST Master 1 Module is the CST Master

set.

Time.CSTDuplicateDetect
If the module is attempting to be the CST Master but there is already another CST Master on the local rack the module will set this bit and stop attempting to be the CST Master.

0	There is no other CST Master on the local rack
1	There is another CST Master on the local rack

Time.DemoModeActive
When the module is operating in demo mode this bit is set.

0	Demo Mode is inactive
1	Demo Mode is active

Time.Year
The current year received from the time source.

Example:	
27/04/2010 13:45:22 – 234567us	Year = 2010

Time.Month
The current month received from the time source.

Example:	
27/04/2010 13:45:22 – 234567us	Month = 4

Time.Day
The current day received from the time source.

Example:	
27/04/2010 13:45:22 – 234567us	Day = 27

Time.Hour
The current hour received from the time source.

Example:	
27/04/2010 13:45:22 – 234567us	Hour = 13

Time.Minute
The current minute received from the time source.

Example:	
27/04/2010 13:45:22 – 234567us	Minute = 45

Time.Second
The current second received from the time source.

Example:	
27/04/2010 13:45:22 – 234567us	Second = 22

Time.Microsecond
The current microsecond received

Example:	
27/04/2010 13:45:22 – 234567us	Microsecond = 234567

from the time source.	

NOTE: **The time is only valid if the Time.TimeValid bit is set.**

Time.UTC

This is the current UTC (Coordinated Universal Time) in microseconds since the time base. The time origin is based on pre- or post RSLogix v16. Please refer to the example code how this can be used to time-stamp events in Sequence-of-Events (SOE) modules.

Example:	
30 April 2010 06:23:41:377069us	UTC = 1209536621000000

Time.CST

This is the current CST of the local rack (depending on the CST Master) in microseconds.

Example:	
CST Master running for 1 hour	CST = 3600000000

Time.CSTOffset

This is the difference between the UTC and CST in microseconds. This can be used to set the wallclock in the controller. Please refer to the example code.

Example:	
CSTOffset = UTC - CST UTC = 1209536621000000 CST = 3600000000	CSTOffset = 1209533021000000

GPS.GPSLock

When using GPS as the time source this bit will indicate if the GPS receiver has lock.

0	GPS receiver does not have lock
1	GPS receiver has locked onto sufficient satellites

GPS.AntennaOK

When using GPS as the time source this bit will indicate if the antenna is connected and is opertational.

0	The antenna is either no present to faulty
1	The antenna is connected correctly

GPS.PDOPOk

Position Dilution of Precision occurs when although there are sufficient satellites in lock, 2 or more of them appear to occupy

0	PDOP is currently active
1	PDOP is not active

similar positions in the sky and thus the number of effective satellites is decreased.

GPS.WarmStart
This bit will indicate if the GPS receiver had battery backup when the power was lost. A warm start will significantly help to reduce the time at startup to get lock on sufficient satellites.

0	GPS receiver did not have a warm start
1	GPS receiver had a warm start

GPS.DGPS
This bit will only be valid when using an external GPS. If set the GPS receiver is receiving differential corrections which will improve the position accuracy.

0	GPS receiver is not receiving differential corrections
1	GPS receiver is receiving differential corrections

GPS.PPS
The pulse per second toggles at the exact moment the second changes and the microseconds are zero. Note that because the RPI is 10ms the accuracy is lost in the input image.

0	It has been more than 100ms since the last second roll-over pulse
1	It has been less than 100ms since the last second roll-over pulse

GPS.FaultCode
This is reserved.

This is reserved.

GPS.Mode
This is reserved.

This is reserved.

GPS.SVCount
The number of satellite vehicles that the GPS receiver is locked on.

This will be a number between 0 and 12

GPS.Latitude
Current position Latitude in degrees.

Example:	
S26°05'17.0" E28°00'21.3" Elev: 1577m	Latitude = -26.088087

Example:	

GPS.Longitude Current position Longitude in degrees.	S26°05'17.0" E28°00'21.3" Elev: 1577m	Longitude = 28.00586
GPS.Altitude Current position Altitude in meters.	**Example:** S26°05'17.0" E28°00'21.3" Elev: 1577m	Elevation = 1577
GPS.PositionX Distance from Earth-centre along the X – axis in meters.	**Example:** S26°05'17.0" E28°00'21.3" Elev: 1577m	ECEF X = 5062108.5
GPS.PositionY Distance from Earth-centre along the Y – axis in meters.	**Example:** S26°05'17.0" E28°00'21.3" Elev: 1577m	ECEF Y = 2692197.3
GPS.PositionZ Distance from Earth-centre along the Z – axis in meters.	**Example:** S26°05'17.0" E28°00'21.3" Elev: 1577m	ECEF Z = -2788525.8
GPS.RelativePositionX This is reserved.	This is reserved.	
GPS.RelativePositionY This is reserved.	This is reserved.	
GPS.RelativePositionZ This is reserved.	This is reserved.	
GPS.VelocityNorth Current Northerly Velocity in meters per second (m/s)	A negative value indicates southerly direction of movement. Only applicable with GPS as the time source.	
GPS.VelocityEast Current Easterly Velocity in meters per second (m/s)	A negative value indicates westerly direction of movement. Only applicable with GPS as the time source.	

GPS.VelocityUp Current Upward Velocity in meters per second (m/s)	A negative value indicates downward direction of movement. Only applicable with GPS as the time source.
GPS.VelocityX Speed with respect to the X – axis in meters per second (m/s)	The X-axis is defined as the vector with origin at the earth's centre and passing through the intersection of the equator and Greenwich meridian.
GPS.VelocityY Speed with respect to the Y – axis in meters per second (m/s)	The Y-axis is defined as the vector with origin at the earth's centre in the same plane as the X-axis, at 90°
GPS.VelocityZ Speed with respect to the Z – axis in meters per second (m/s)	The Z-axis lies at a 90 angle to the equatorial plane and extends through the North Pole.

OUTPUT IMAGE

⊟ Local:8:O	{...}	{...		HT:1756HP_TIME:O:0
⊞ Local:8:O.IRIGYear	0		Decimal	INT
⊞ Local:8:O.UTC_Offset	0		Decimal	INT
Local:8:O.ReferencePositionX	0.0		Float	REAL
Local:8:O.ReferencePositionY	0.0		Float	REAL
Local:8:O.ReferencePositionZ	0.0		Float	REAL

IRIGYear We the module has a IRIG-B time source the year must be provided in the output image as the year is not passed over IRIG-B. Thus the user must enter the current year.	

Example:	
30 April 2010	IRIGYear = 2010

UTC_Offset The UTC_Offset is only used when the time source is IRIG-B and PTP output is enabled. IRIG-B provides the UTC time while PTP requires TAI (International Atomic Time). The difference between the two is the UTC offset.	

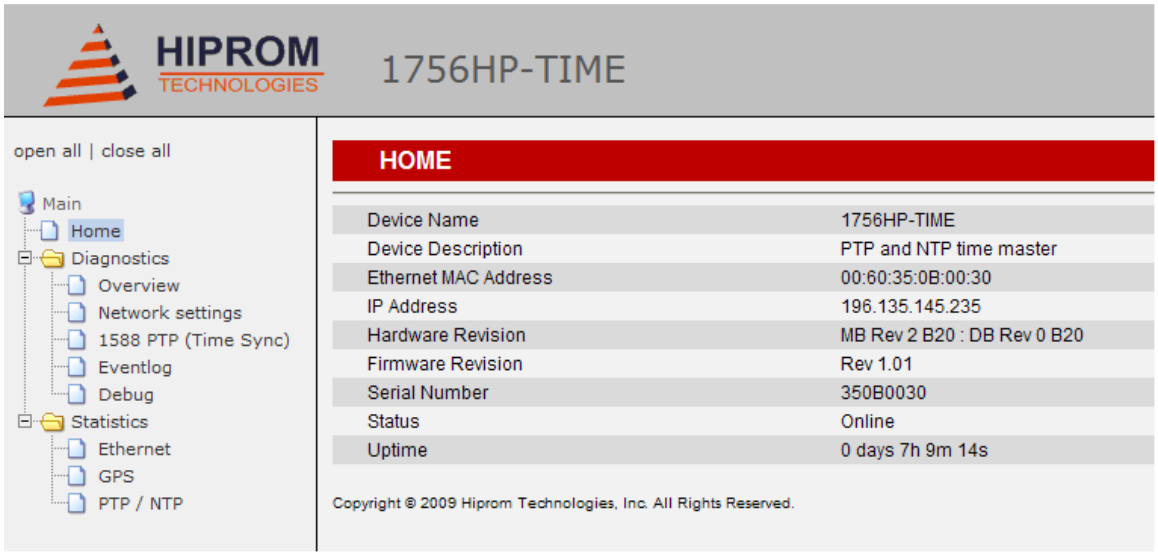
Example:	
30 April 2010	UTC_Offset = 34

*** The user will need to see what is the current UTC Offset as it changes approximately every 18 months.**

ReferencePositionX This is reserved.	This is reserved.
ReferencePositionY This is reserved.	This is reserved.
ReferencePositionZ This is reserved.	This is reserved.

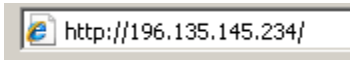
Web Interface

The web interface can be used from any PC that has a web browser. It will provide all the diagnostics of the module as well as each field device as shown below:



The web interface can be accessed by entering http:// IP address into the address bar of the browser as shown below:

Eg. 1756HP-TIME IP address: 196.135.145.234



1588 PRECISION TIME PROTOCOL (PTP)

The 1756HP-TIME module supports 1588 PTP which allows for high precision time synchronization over an Ethernet network.

NOTE: **RSLogix v18 and newer will support 1588 PTP. This is not supported in the previous versions.**

NOTE: **The 1756HP-TIME module supports PTP version 2.**

Time Module as a PTP Master

PTP will be used to synchronize Rockwell devices supporting this protocol. To configure the PTP settings of the module the CIP Sync object must be used. Please refer to the CIP documentation for more detail on how to use this object.

When receiving sufficient satellites the 1756HP-TIME module can synchronize devices to within 100ns (using 1588 PTP) when connected directly to the device that is being synchronized. If these devices are connected via a switch that does not support 1588 PTP the time synchronization will degrade as there are more random delays which will affect the mean delay time calculation used for time synchronization. Thus the more switches and/or interfaces between the 1756HP-TIME module and the device being synchronized, the bigger the spread of random time delays which will result in lower time sync accuracy.

If the user has enabled PTP on the EN2T / EN2TR then it will automatically look for any other 1588 PTP devices and determine who has the highest quality clock. Once this is done it will automatically sync to this clock.

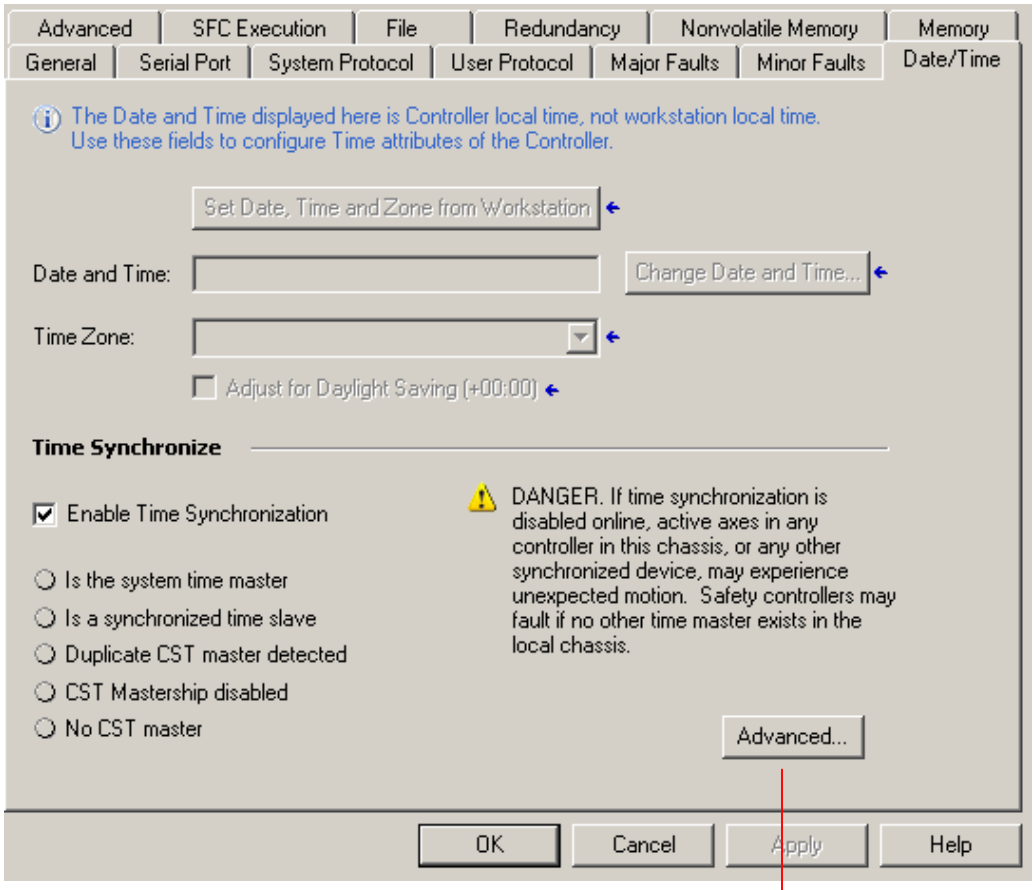
NOTE: **1588 PTP uses a multicast address thus switches must be setup to allow multicast or have IGMP enabled.**

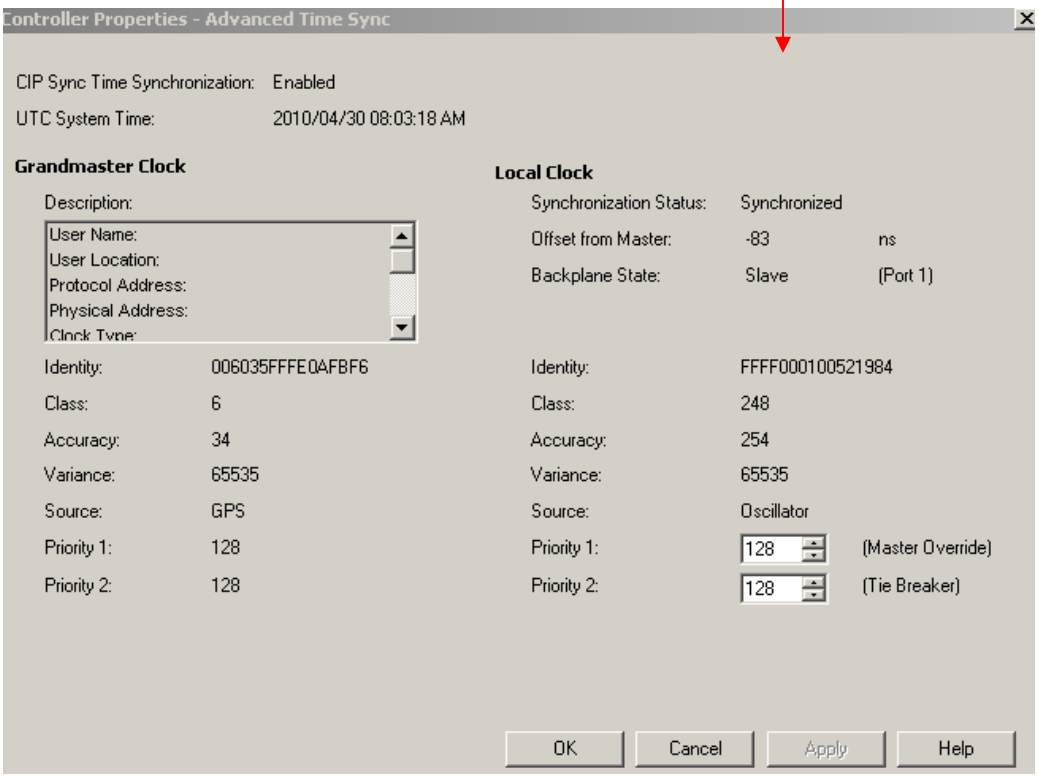
The EN2T / EN2TR are boundary clocks which mean they can be a time “slave” on one interface and a time “master” on another. Thus they can act as a transparent gateway when a Logix Controller uses the time Grand Master which might be on Ethernet (1756HP-TIME). The EN2T / EN2TR must have *CIP Sync and Motion* enabled as shown below. In the Date/Time page of the controller under *Time Synchronize* there is a tick box **Enable Time Synchronization**. If this is set the Controller will look for the highest quality clock on the backplane. If there is an EN2T / EN2TR in the local rack that is synchronized to a 1756HP-TIME the Logix Controller will synchronize to the 1756HP-TIME module via the EN2T / EN2TR.

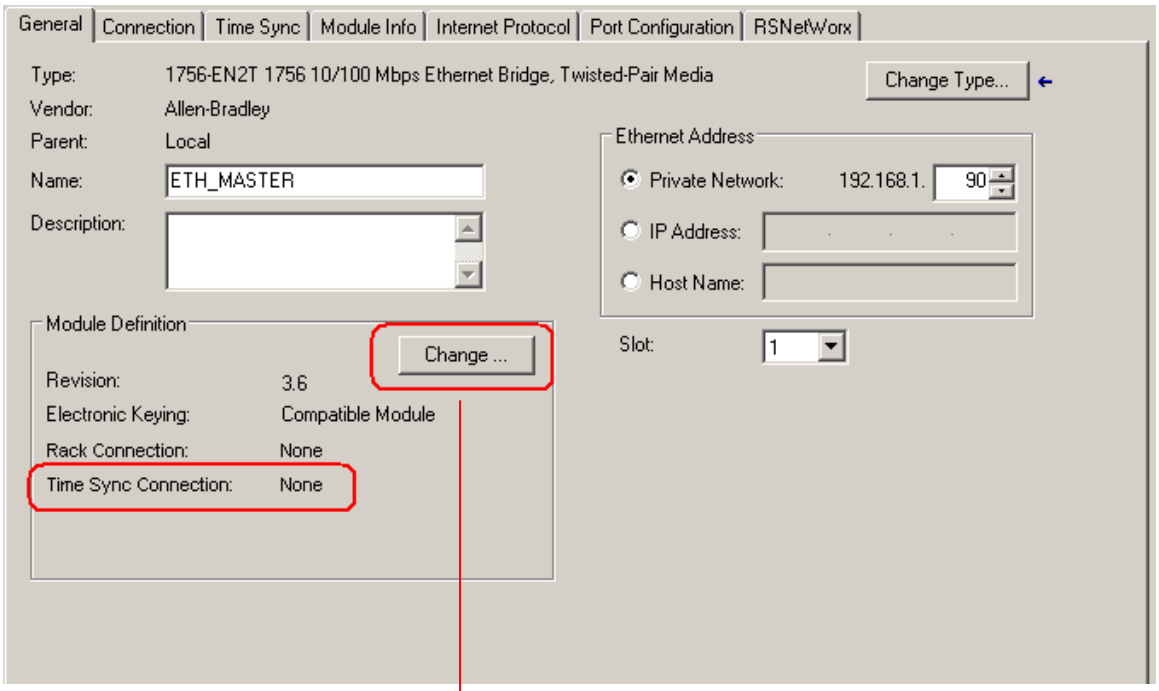
Below are screen grabs of the *Date/Time* tab in the controller as well as the CIP Sync page which is launched from the *Advanced* button.

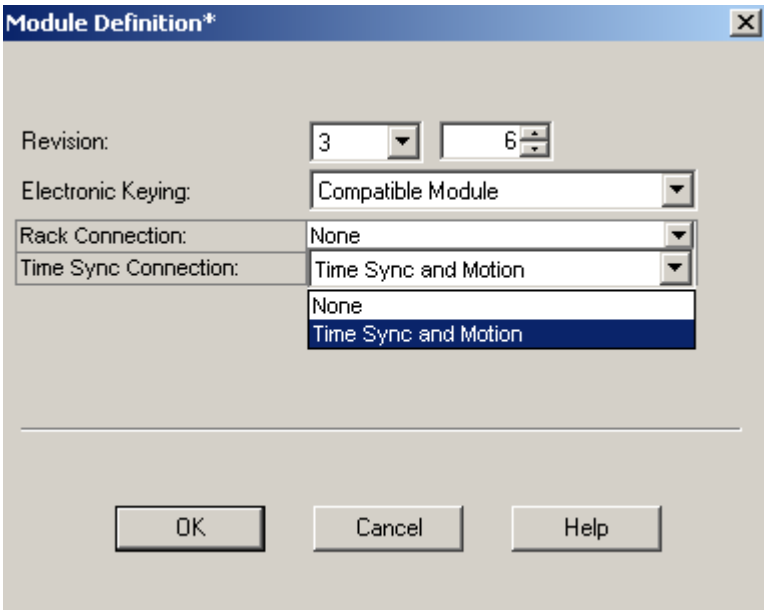
NOTE: **Most devices supporting 1588 PTP defaults to *PTP Enabled: FALSE.* PTP must be enabled on the devices before time synchronization will start.**

Please refer to *1756HP-TIME PTP implementation.doc* for implementation details.


Advanced
SFC Execution
File
Redundancy
Nonvolatile Memory
Memory
General
Serial Port
System Protocol
User Protocol
Major Faults
Minor Faults
Date/Time
The Date and Time displayed here is Controller local time, not workstation local time.
Use these fields to configure Time attributes of the Controller.
Set Date, Time and Zone from Workstation
Date and Time:
Change Date and Time...
Time Zone:
Adjust for Daylight Saving (+00:00)
Time Synchronize
Enable Time Synchronization
DANGER. If time synchronization is disabled online, active axes in any controller in this chassis, or any other synchronized device, may experience unexpected motion. Safety controllers may fault if no other time master exists in the local chassis.
Is the system time master
Is a synchronized time slave
Duplicate CST master detected
CST Mastership disabled
No CST master
Advanced...
OK
Cancel
Apply
Help


Controller Properties - Advanced Time Sync
CIP Sync Time Synchronization: Enabled
UTC System Time: 2010/04/30 08:03:18 AM
Grandmaster Clock
Description:
User Name:
User Location:
Protocol Address:
Physical Address:
Clock Type:
Identity: 006035FFFE0AFBF6
Class: 6
Accuracy: 34
Variance: 65535
Source: GPS
Priority 1: 128
Priority 2: 128
Local Clock
Synchronization Status: Synchronized
Offset from Master: -83 ns
Backplane State: Slave (Port 1)
Identity: FFFF000100521984
Class: 248
Accuracy: 254
Variance: 65535
Source: Oscillator
Priority 1: 128 (Master Override)
Priority 2: 128 (Tie Breaker)
OK
Cancel
Apply
Help


General
Connection
Time Sync
Module Info
Internet Protocol
Port Configuration
RSNetWorx
Type:
1756-EN2T 1756 10/100 Mbps Ethernet Bridge, Twisted-Pair Media
Change Type...
Vendor:
Allen-Bradley
Parent:
Local
Name:
ETH_MASTER
Description:
Ethernet Address
Private Network:
192.168.1.
90
IP Address:
Host Name:
Module Definition
Change ...
Revision:
3.6
Electronic Keying:
Compatible Module
Rack Connection:
None
Time Sync Connection:
None
Slot:
1


Module Definition*
Revision:
3
6
Electronic Keying:
Compatible Module
Rack Connection:
None
Time Sync Connection:
Time Sync and Motion
None
Time Sync and Motion
OK
Cancel
Help

Time Module as a PTP Slave

The 1756HP-TIME module can be set to be a PTP slave. It will automatically synchronize to the best PTP clock on the Ethernet network, using the best master clock algorithm (BMC).

NOTE: **The TIME module cannot act as a boundary clock. If PTP is selected as the input time source, then PTP output will be disabled.**

Using PTP as the time source enables NTP and IRIG-B as the output modes. Thus the accuracy is limited to the accuracy of the respective output modes.

NOTE: **The accuracy of the PTP time is dependent on the quality and reliability of the Ethernet network. The PTP algorithm allows for network delays, but needs a constant delay to synchronize accurately. PTP switches prioritize PTP messages to keep the delay constant, and are therefore preferred for PTP networks.**

NETWORK TIME PROTOCOL (NTP)

Time Module as an NTP Server

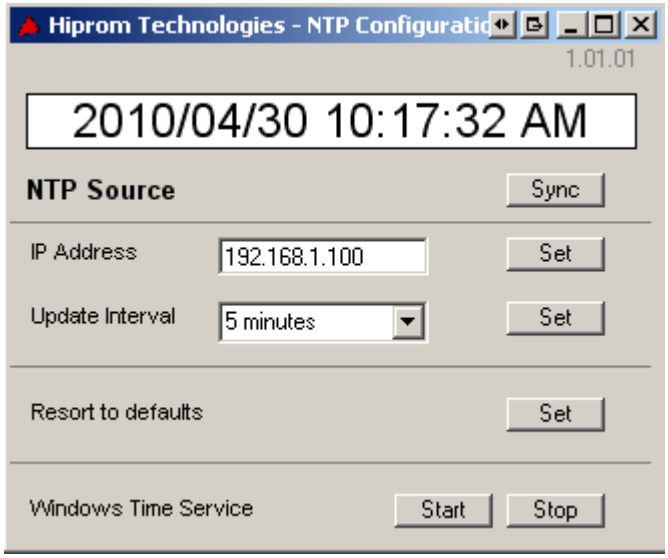
The 1756HP-TIME module supports the Network Time Protocol (NTP) which allows for time synchronization over an Ethernet network. NTP clients can be synchronized to around 1ms of the NTP client depending on the network.

NTP is generally used when synchronizing personal computers or domain controllers. The user can use the supplied application (HSNTP) to set the Windows Time Service to synchronize to the 1756HP-TIME module.

NOTE: **The 1756HP-TIME module supports NTP v3 RFC1305.**

NOTE: **When a PC is on a domain it will try and synchronize to the domain controller. Thus the user can setup the domain controller to synchronize to the 1756HP-TIME.**

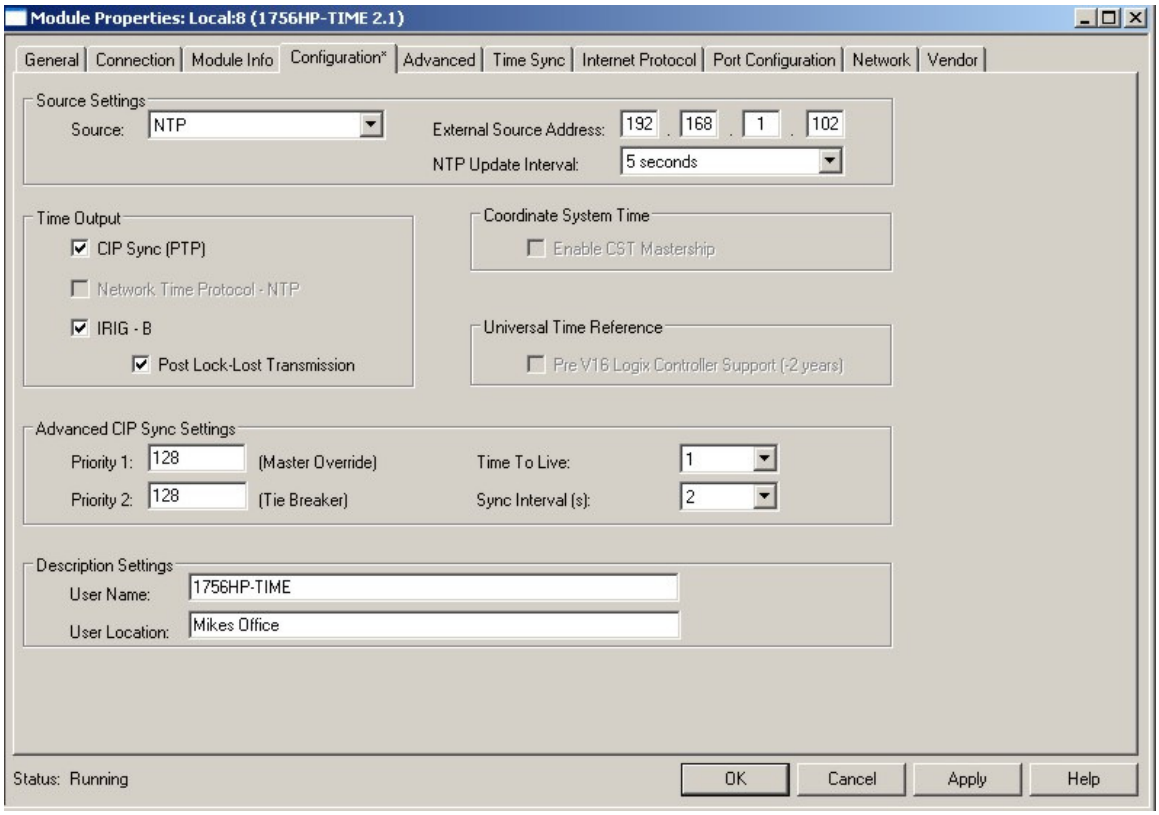
Below is a screen grab of HSNTP which can be used to synchronize a PC to the 1756HP-TIME.



- Before the user can synchronize the current PC to the NTP source the user will need to enter the IP address of the NTP source. In the example the IP 192.168.1.100 is used; which will be the IP address of the 1756HP-TIME module. Once the user has entered the IP address the *Set* button must be pressed to update the data.
- The update interval is the time interval at which the NTP client will try and synchronize it time with that of the NTP server. The user must press the *Set* button to save the changes.
- Once all the above changes have been made the user will need to *Stop* and *Start* the Windows Time Service to allow it to load the new settings.
- Once the user has entered the correct destination IP address the *Sync* button can be pressed to immediately synchronize the time with the NTP server.
- The user can set all the changes made back to defaults by clicking the *Set* button next to Resort to defaults.

Time Module as an NTP Client

The 1756HP-TIME module can be configured to connect to an external NTP source (the module can also accept SNTP as a time source protocol), and then output the time on the backplane, as PTP or IRIG-B time.



To configure the module to connect to an NTP source, open the module properties box and select the configuration tab as shown in the diagram above. In the 'Source Settings' drop-down box select NTP as the source. Once this is selected the 'External Source Address' and 'NTP Update Interval' options become available.

The external source address is the IP address of the NTP source; the NTP update interval specifies how often the time module will discipline its internal clock to the NTP source. The update interval can range from 5 seconds to 1 week.

The frequency of the update interval will affect the accuracy of the time from the module – if the time is not disciplined by the NTP source the time may drift by up to 10µs/s depending on external factors such as temperature and humidity.

In order to keep the time as smooth as possible, the time will only be disciplined at a certain rate until the time is equivalent to the NTP source. This is unless the time of the module becomes more than 1 second different to the source time. If this occurs, the module will 'jump' to the correct time as given by the NTP source.

NOTE: **The accuracy of the NTP time is dependent on the quality and reliability of the Ethernet network. If the update time is set to too high a value the clock may drift and jump. A recommended value of 30 seconds or less is recommended for optimal accuracy.**

If the module loses connection to the NTP source (this will happen if the source does not reply after the update interval time has expired) then the 'lock' LED will become red and the time module will run on its internal oscillator until the source becomes available again. The module will try to reconnect to the NTP source every 10 seconds after a loss of communication.

NOTE: **NTP time as a source is only accuracy to 10 ms therefore the synchronization accuracy using 1588 PTP will be limited to 10 ms.**

IRIG-B

The module can be used as an IRIG-B master (outputs the IRIG-B signal) or an IRIG-B slave (receives the IRIG-B signal from another time master).

NOTE: **The 1756HP-TIME module currently supports the IRIG-B-122 format.**

When the 1756HP-TIME module is an IRIG-B master it will output the current time over the IRIG-B network and synchronize slaves to around 1ms.

When the 1756HP-TIME module is an IRIG-B slave it will receive the time signal from a master and display it in the input image of the 1756HP-TIME module.

The time received from the IRIG-B network can be used in a sequence of events solution. Please refer to *CST and UTC Time Conversion* section.

The 1756HP-TIME module can also be used to output 1588 PTP and NTP whilst receiving time from an IRIG-B source.

NOTE: **If the module has an IRIG-B time source (which is accurate to 1ms) the synchronization accuracy using 1588 PTP will be limited to 1ms.**

CST AND UTC CONVERSION

The 1756HP-TIME module can also be used to convert CST or UTC time formats to Gregorian time (year, day, month etc). The GPS module accurately tracks the local CST and UTC time to the current Gregorian time. Thus the different drifting rates of different CSTs is also compensated for. In a sequence of events (SOE) solution the SOE module (for example 1756-IB16ISOE) will report the event time in either CST or UTC time formats.

NOTE: **It is important that a CST master is present when using a sequence of events solution.**

NOTE: **The user also needs to ensure that there is no duplicate CST master. This is indicated in 1756HP-TIME module as well as the Logix Controller.**

These values can be passed to the 1756HP-TIME module (using unconnected message block) and converted to Gregorian time. The 1756HP-TIME module will track the last 12 hours of CST, UTC and Gregorian time formats. Thus if an event has occurred the user has up to 12 hours to convert the event time. Please refer to the example code for further information.

The CST offset can also be used to discipline the wall clock by using a SSV instruction to pass the CST offset. Please refer to the example code.

SPECIFICATION

Electrical

specification	*value*
Power Requirements Power Consumption	All power is derived from the 1756 backplane. Current draw @ 5 V – 925 mA Current draw @ 24 V – 1.63 mA
Operating Temperature	0 to 50 ºC
Storage Temperature	0 to 50 ºC
Relative Humidity	5 to 95 % non-condensing
Operating Shock	
Storage Shock	
Vibration	
Emissions	
ESD Immunity	
Radiated RF Immunity	
EFT/B Immunity	
Conducted RF Immunity	
Enclosure Type Rating	IP20
Ethernet Conductor	CAT5 STP

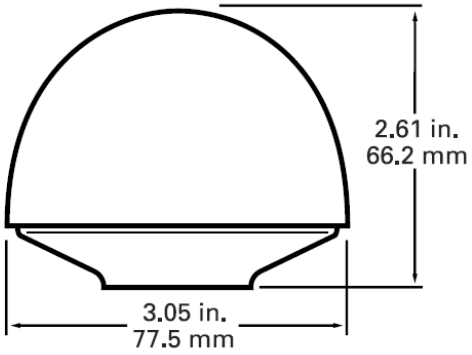
Cable

specification	*value*
Type	RG-59 or equivalent
Impedance	75 Ohm
Capacitance	16.5 pF / foot (54.1 pF / meter)

Shield	Foil or copper braid (100% coverage)
Connectors	SMA (module side) and TNC (antenna side)
Signal attenuation	< 10 dB / 100 feet for cable and connectors

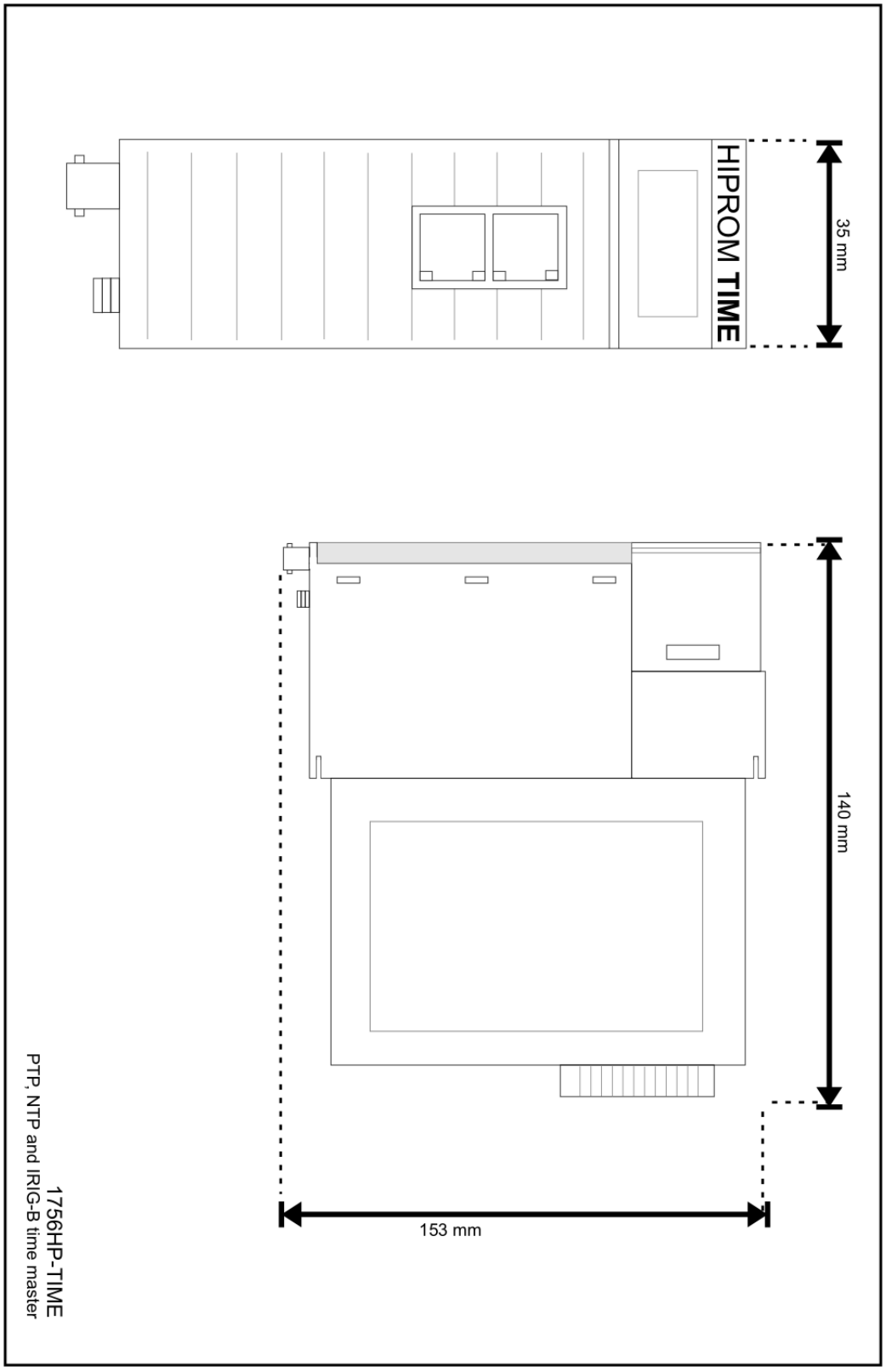
Antenna

specification	***value***
Dimensions	3.05” D x 2.61” H (77.5mm x 66.2 mm)
Weight	6.0 oz (170 grams)
Connector	TNC
Mounting	3/4" pipe thread



For more information regarding this antenna please visit the Trimble website: www.trimble.com

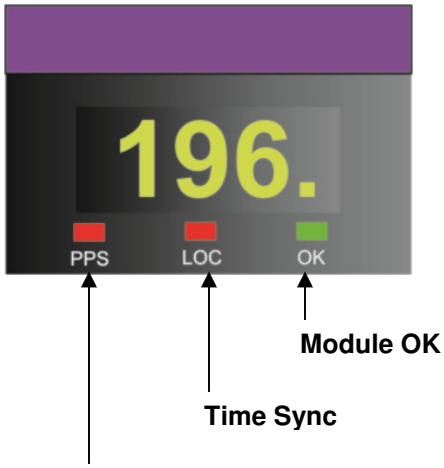
Mechanical


HIPROM TIME
35 mm
140 mm
153 mm
1756HP-TIME
PTP, NTP and IRIG-B time master

APPENDIX A

Display Status

The display of the 1756HP-TIME module will provide certain diagnostics to the user as given below:



Module OK

This will show green if the module has booted successfully. If the LED is red the module has a hardware fault.

Time Sync

If the module has locked on the time source the LED will be green. If the module does not have lock this will indicated red.

Pulse per Second

This LED will be toggled every second for 100ms. This will be at the exact GPS PPS. If this LED is green it means that the GPS receiver has lock. If this LED is red the GPS receiver does not have lock. When the module is set to be an IRIG-IN or slave this bit will toggle every time a reference frame is received.

LCD

Below is the list of messages that can be displayed by the LCD of the module:

- **No Antenna**

No antenna has been connected to the SMA connector.

- **No Clear Sky View**

The signals received from the satellites are weak which indicates that the view of the sky is being obstructed.

- **Tracking satellites**

The GPS receiver has locked onto one or more satellites.

- **x satellites locked**

The GPS receiver has locked onto x amount of satellites.

- **No Time**

No time has been received.

- **PDOP too high**

When the locked satellites are in close proximity of each other the receiver is said to have a high Position Dilution of Precision which will result in low position accuracy. This is usually found when the antenna only has a restricted view of the sky.

- **DEMO MODE**

When the correct DIP switch has been set the module will be in demo mode.

- **ControlFlash. Do not power down!**

If a firmware upgrade is being done this message will appear.

- **RST**

This will be received if the module has received a reset CIP command.

- **Debug Mode**

When the correct DIP switch has been set the module will be in debug mode. The user must never put the module in debug mode.

- **192.168.1.100**

The above is an example of an IP address that will scroll across the LCD.

- **Time Source – GPS**

This is used to display the current time source being used. The various sources are GPS, IRIG-B, NTP, PTP and External. Where applicable, the IP address of the source will also scroll across the display.

- **BOOTP enabled**

This will be displayed if BOOTP is currently active on the module. The user will have to use a BOOTP server to set the IP address.

- **Safe Mode**

When the correct DIP switch has been set the module will be in safe mode. This means that the module has booted from the code that it was shipped with.

APPENDIX B

MESSAGE BLOCKS

CST -> UTC and Gregorian time conversion

Below is the structure of the message block:

Message settings	
Message Type	CIP Generic
Service Type	Custom
Service Code	32h
Class	70h
Instance	01h
Attribute	01h
Date elements	
Source Element	Event_CST[0] *
Source Length	8
Destination	Event.Year *

* Refer to the example code

UTC -> Gregorian time conversion

Below is the structure of the message block:

Message settings	
Message Type	CIP Generic
Service Type	Custom
Service Code	33h
Class	70h
Instance	01h
Attribute	01h
Date elements	
Source Element	Event_UTC[0] *
Source Length	8
Destination	Event.Year *

* Refer to the example code

Satellite information

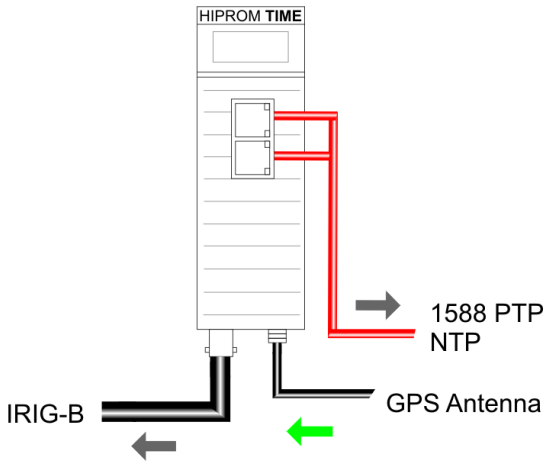
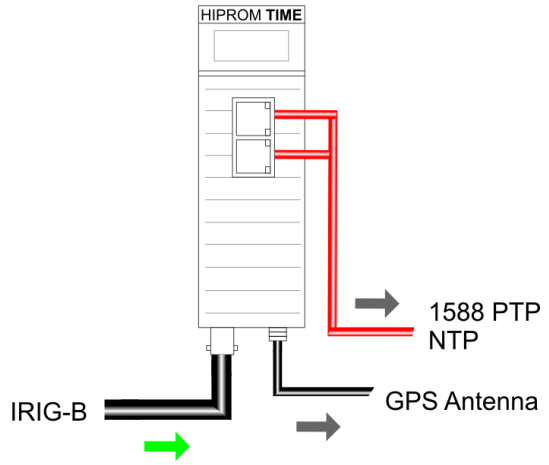
Below is the structure of the message block:

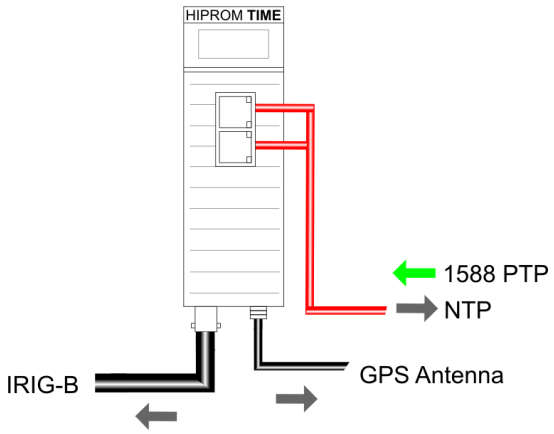
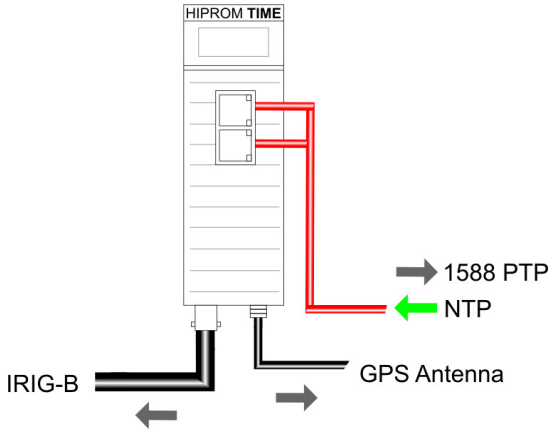
Message settings	
Message Type	CIP Generic
Service Type	Custom
Service Code	32h
Class	71h
Instance	01h
Attribute	01h
Date elements	
Source Element	
Source Length	0
Destination	SatInformation[0].PRN *

* Refer to the example code

APPENDIX C

Operating Modes

SOURCE	OUTPUT	
GPS	IRIG-B 1588 PTP NTP Backplane	
IRIG-B	1588 PTP NTP Backplane	

PTP	IRIG-B NTP Backplane	
NTP	IRIG-B 1588 PTP Backplane	

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